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ABSTRACT

Presented is a resource book to be used with instructional kits for elementary school science students, grade 5. The individual units at this grade level are based on curriculum which has been developed by the National Science Foundation in the 1960s and revised to meet student and teacher identified needs in Anchorage, Alaska. Six units are included within this guide. Each unit lists kit and non-kit items, supplemental materials, teacher background information, and proposed schedule. Worksheet masters are also included. Unit topics include Experiments with Paper and Ice Cubes, Small Things, Electricity, Magnets, Atoms and Molecules, Plants and Animals, and Ecosystems. (CS)

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ELEMENTARY SCIENCE GUIDE

5TH GRADE

1978

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NATIONAL INSTITUTE OF EDUCATION

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SUPERINTENDENT OF SCHOOLS

ANCHORAGE SCHOOL DISTRICT

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ANCHORAGE, ALASKA 99504

SE 031 449

FOREWORD

This Resource Book has been prepared for use with instructional kits distributed through the Anchorage School District Science Center. These kits were developed by the Elementary Science Curriculum Committee under funding by ESEA Title IV B & C in response to student and teacher identified needs.

The individual units at each grade level are based on curriculum which has been developed by the National Science Foundation in the 1960's. The curriculum has been taught by thousands of teachers throughout the United States. The Anchorage School District adopted this curriculum and our Anchorage teachers have adapted it to fit our needs and our scope and sequence. The Anchorage School District is enthusiastic about this effort and believe that this guide and the Science Center will represent more effective and efficient ways of teaching science.

The process of curriculum planning and development requires the help of many teachers, principals and administrators. We appreciate the cooperation and assistance of everyone who has contributed to this project.

E.E. (GENE) DAVIS, ED.D
ASSISTANT DEPUTY SUPERINTENDENT

EED:dc

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The development of this guide represents the contribution of many talented people during the past two to three years. We are very grateful to the following people for the unique contribution each of them made in developing our science program.

The guide material was written by the following people:

1st trial edition 4-6 writing team summer 1977.

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The Minneapolis School District - Minneapolis, Minnesota -
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(To be taught in any sequence)

Experiments with Paper and with Ice Cubes

Small Things

Electricity

Magnets

Atoms and Molecules

Plants and Animals: Ecosystems

OUTCOME STATEMENT

For Students Grades K-6 -- Science

The major outcome of science education in the Anchorage Schools is the development of scientifically literate citizens. A scientifically literate person is generally described as a person who:

- Understands enough of the fundamental concepts of the physical and biological nature of the world so that he/she may act responsibly.
- Possesses science skills and processes that give rise to facts and concepts.
- Possesses attitudes or values generally associated with science such as curiosity and respect for data.
- Uses science concepts, skills and values in making decisions as he/she interacts with other people and with his/her environment.
- Is aware of the interrelationship taht exists between cultural, philosophical, environmental, and social changes and scientific and technological advancements.

The role of the elementary school is to provide concrete, first hand experiences for students so that they may <u>begin</u> the process of becoming scientifically literate citizens. Because a child's mind changes in the manner it operates, and does not simply increase in capacity as it matures, the K-6 outcomes will be concrete and demand direct student observations. Nevertheless, these outcomes are important prerequisites for the later outcomes.

By the end of the sixth grade a student should be able to:

- Observe and describe a simple event using more than one sense.
- Record and share observations with others.
- Classify a set of objects.
- Collect and organize simple data.
- Interpret the meaning of simple data
- Set up a simple experiment to answer a question
- Read scientific materials critically.

OUTCOME STATEMENT (Continued)

- Demonstrate a basic understanding of the function of the ecosystem and his/her relationship to it.
- Demonstrate a basic knowledge of the systems of the human body.
- Demonstrate a basic knowledge of physical science concepts to which he/she has been introduced.

1 Each unit will have:
A. A listing of kit and non-kit items.
B. Supplemental materials list.
C. Teacher background information.
D. A schedule.

2 The units have been developed to be taught anytime throughout the year.

3 The approximate times needed for each unit are included to help you in your long range planning.

4 Worksheet masters are included in your guide for reproducing.

5 Call the Science Center if you have a problem.

TEACHER'S RESOURCE BOOK

FOR

EXPERIMENTS WITH PAPER AND WITH ICE CUBES

GRADE 5

September 1978

Superintendent of Schools
Anchorage School District
4600 DeBarr Road, Anchorage, Alaska 99504
Telephone (907) 333-9561, Extension 231

A Program Development Division Production

EXPERIMENTS WITH PAPER AND WITH ICE CUBES

GRADE 5

FOR A CLASS OF 32:

KIT

Blotter paper sheet
12 containers - 16 oz. size
12 containers - 12 oz. size
Alcohol/Vinegar - 2 pints each
Weights (several hundred)
32 droppers
100 - 30 cc cups
20 cylinders - tall red cylinders
20 flat cubes - short red cylinders
different sized containers
Hot plate
16 thermometers
32 rulers, metric and English
4 oz. oil
3 styrofoam trays
1 cooler
1 box baggies
20 tongue depressors

NON-KIT

Containers for hot/cold water
Hammer
Cleanser
Paper towel rolls
Clock with second hand
Calculator

EXPERIMENTS WITH PAPER AND WITH ICE CUBES

GRADE 5

INTRODUCTION:

The lessons in this unit have been written so that your students will be able to carry out experiments with simple materials - blotter paper, paper towels, ice cubes, weights, different liquids - and draw conclusions based on their observations of the experiments.

It is based on the idea that children will achieve more when they become involved in the experiment. They will be able to see for themselves that certain results occur when simple experiments are performed.

At times, throughout the unit, you will want the students to proceed individually and at their own speed. At other times you will want the whole class to work on the same activity.

The lessons are designed to allow your students to follow many side paths for experimentation. For example, when you reach questions about factors affecting the melting time of ice cubes, you may wish to let your students explore several ideas besides the activities mentioned in the unit. The same holds true with variables affecting liquid rise in blotter paper. Your schedule and the student's interest should be the only limits to this kind of creative work.

You will probably find it best to divide your class into working groups of two and four students. This arrangement will enable the students to work and converse easily as they discover new things. This arrangement will allow you to become a "Classroom Manager" rather than a source of all information. You will be free to move from group to group, encouraging the students to answer their own questions by experimentation.

Teachers who have used a discovery approach to teaching have found it important to have four points well in mind before beginning each lesson:

1. Lead-off Questions
2. Follow-up Questions
3. Activities
4. Discussion Questions

If you can proceed with these ideas you should find the unit of work exciting for both you and your students.

Student pictures, data tables, reports, talks are all part of student involvement for this unit. It is important to blend together the activities of each lesson with these reporting techniques.

SCHEDULE:

The 6-lesson unit has been designed to take from 5-10 hours depending upon the maturity of the students and whether you choose to do the optional activities. It should be run over a three week period of time. The time period could be broken into 45 minute periods, two or three times each week. Using the 45 minute pattern will allow enough time for your students to explore their ideas. Because three of the lessons call for ice cubes, you may find it more convenient to teach this unit during the winter months.

EVALUATION:

It is difficult to design evaluative devices for the experimental science described in this unit. If you allow your students the freedom to explore you will never be sure what has happened until it does. If you do feel that evaluation is needed, two possible directions can be followed:

a. Observation - This is perhaps the most natural form of evaluation. If you use observation techniques for the unit of work, it will be necessary for you to move from group to group, asking questions and listening to your students. Watch each student closely as he or she applies what they have learned to new situations, especially to see if he or she understands and can apply experimental method and can identify and control variables.
b. Data Sheet - This sheet can offer a more formal kind of evaluation.

ADVANCE PREPARATION:

Cutting blotter paper strips, purchasing 5 rolls paper towels, and making ice far enough in advance so there is no unfrozen water left in center of containers.

RATIONALE:

The main purpose of this unit is to give the children an opportunity to use experimental method and to control and manipulate variables.

Experimental method is an orderly procedure utilized by persons doing scientific experimentation. It consists of the following steps:

a. Finding a problem to investigate.
b. Stating a hypothesis (phrasing the problem in such a way that it can be tested).
c. Collecting data (the quantifying of information obtained from observation and experimentation).
d. Interpreting data (arithmetic operations performed on the data).
e. Drawing a conclusion (what was the answer to the problem that was investigated).

RATIONALE (continued)

Variables are the factors which may affect the outcome of an experiment. It is often difficult to be aware of every variable in an experimental situation, but several variables are usually readily apparent. In order to obtain valid experimental results, investigators need to manipulate, or experiment on, only one variable at a time. For example, if you compare melting time of a 30 cc ice cube standing in 1 liter of water at 30° C with the melting time of a 30 cc ice cube standing in 1 liter of alcohol at 20° C, you cannot tell if the difference in melting times was due to the temperature difference or to the difference of substance the ice melted in. Therefore, all other variables need to be determined and then controlled, that is kept fixed or held constant while the one variable in question is experimented on.

The terms "variable," "controlling variables," "manipulating variables," and "hypothesis" are utilized again in the Atoms and Molecules 5 Unit and also in certain 6th grade units. The concept of controlling variables is essential to the understanding of scientific method, however, it is a formal operation as defined by Piaget and so we do not expect the majority of 5th graders to be able to understand and also apply the concept at this first exposure.

LESSON I

Concepts:

1. A variable is a factor that affects the outcome of an experiment.
2. Several variables influencing an experiment can be identified.
3. An experiment can be set up to prove or disprove a hypothesis that a certain variable affects the outcome of an experiment.
4. Variables can be controlled or manipulated.

Materials:

KIT	NON-KIT
Blotter paper - 1 large sheet	Pot to mix up salt and water
Containers	Clock with second hand
1/2 lb. salt	
1 pt. alcohol	
32 metric rulers	

Advance Preparation: Cut a sheet of blotter paper into 36 5-inch long strips, 1 1/2 inches wide; 72 5-inch strips, 1 inch wide, and 36 5-inch strips, 1/2 inch wide.

Procedure:

1. Hand out 1 strip of 1 inch wide blotter paper, one container half full of water, and a ruler to each child.
2. Review metric linear measure by asking children what the length and width of a ditto sheet or notebook paper is in millimeters and centimeters.
3. Have the children measure and draw a pencil line 10 mm or 1 cm from the bottom of the strip.

(Lead-Off Question)

4. Ask, "What do you think will happen to the blotter paper if we dip the paper in water up to the line and hold it there for 30 seconds, then vertically for 30 seconds before we measure it?"
5. Ask, "Let's try to predict how high the water will rise on the paper." Record predictions on the board.

Procedure:

6. Instruct the children, when you give the signal, to dip the blotter paper in the water up to but not beyond the 10 mm line and hold it steadily there for 30 seconds. Then when you give the signal, to raise the paper out of the water and hold it vertically for 30 more seconds. Then on your signal, they should lay the paper flat and measure the average height of the water from the bottom of the paper. Record the heights on the board and average them to find the average water rise.

LESSON I (continued)

(Follow-Up Question) 7. Ask, "What factors may have affected how high the water rose in the paper?" List the children's responses on the board. Children's responses will usually include several of the following: The depth the paper was immersed, the length of time it was immersed, the length of time the paper was held in the air before it was measured, the substance in which the paper was immersed, the thickness of the paper, the kind of paper, the temperature of the water, and the humidity of the air.

Procedure: 8. Explain to the children that such factors that may affect the rise of water in blotter paper or the outcome of any experiment are called "variables." Write the term on the board above the list the children have made.

(Follow-Up Question) 9. Ask, "How could we find out if one of these variables really does affect the rise in blotter paper?" The students will probably suggest to test it.

10. Ask, "Which variable shall we test, or manipulate?" Let the class vote. If the class votes for "thickness" then you already have the cut strips 1 1/2 and 1/2 inch wide. If they vote for "substance," you have salt to mix with water, or alcohol.

11. Ask, "Can you make a statement about this variable predicting how it will affect the rise in blotter paper?" This statement, I think that _____ will cause the level to rise higher/lower than that of 1 inch paper in water to 10 mm for 30 seconds in and 30 seconds out before measuring, is called a Hypothesis. A hypothesis is a statement about a variable that allows it to be tested.

12. Ask, "Could we tell what caused the difference in liquid rise if we compared paper immersed in 10 mm of water to paper immersed in 20 mm in alcohol?" Explain that only one variable at a time can be tested or manipulated and all others must be controlled.

Procedure: 13. Carry out the experiment to see if the variable the children have selected does or does not affect the rise of liquid. You may ask the children for predictions ahead of time. Average results and compare with the results obtained in the first experiment to arrive at a conclusion. A significant difference would be 10 percent or more.

LESSON II WHICH IS THE BEST PAPER TOWEL?

Concepts:

1. There is a difference in the quality of paper towels on the market.

2. Experiments can be performed in a specific manner, and will yield specific results.

Materials:

KIT	NON-KIT
Weights - several hundred	Cleansing powder such as "Gold Dust"
Droppers - 6	Clock with second hand
30 cc containers - 6	5 or 6 rolls paper towels
Larger containers - 6	Calculator
Rulers - 6	
Oil - 4 oz.	

Advance Preparation: From the 5 or 6 brands of paper towels you have purchased, compile an information sheet to be duplicated. Include the name of each brand, manufacturer's claims on wrapper, "Has scrub strength" etc., the number of sheets, how many ply, dimensions, and cost. After you remove the wrappers, you can write the brand name inside the cardboard tube.

Procedure:

1. Ask, "Write down all the ordinary and unusual uses of paper towels you can think of."

2. Students may want to share their ideas with the class.

3. From these ideas, help the students to synthesize the most important qualities of paper towels. Students will usually suggest absorbency, economy, wet, dry, and scrub strength and attractiveness.

4. Introduce the towels and data sheet. (page 19)

(Lead-Off Question)

5. Ask, "Which do you think is the best paper towel?"

Procedure:

6. Arrange for the students to work in groups of 3, 4, or 5. Have each grup appoint a recorder whose job it will be to collect data that has been generated by measuring, counting, etc.

7. Introduce the weights, droppers, rulers, 30 cc containers, containers, cleansing powder, and oil. Explain that each group should select 1, 2, or 3 of the criteria for towels and develop their own experiment to see which towel is best. Help the groups to develop some sort of point system for keeping track of the relative performance of each towel.

As the students formulate their experiments, you may see students doing some the following:

1. Piling weights onto suspended towels to determine strength. You may want to suggest they work over a carpet or newspapers to muffle the crash when the paper breaks.

2. Counting the number of scrubs on a counter top before a wet towel breaks through.

3. Polling classmates and others to see which is most attractive.

4. Using a calculator to determine cost per square foot.

5. Measuring absorbency by seeing how far a given amount of water or oil spreads in a given amount of time, or dipping towels into measured amounts of liquid to see how much is absorbed.

If you see students forgetting about variables, question them to see which variable they are testing. For example, you could ask, "Is it the size of the sheet or the absorbency of the paper which affects how much water is absorbed?"

You could either terminate the lesson after each group has completed one category and let them present their results next time, or you could let them do more than one category today, or you could let them experiment again next time before presenting their results.

LESSON III WHICH IS THE BEST PAPER TOWEL - Conclusion

Concept: Scientists follow an orderly procedure referred to as "experimental method."

Materials:

KIT	NON-KIT
Weights - several hundred	Cleansing Powder
Droppers - 6	Paper Towels
Oil - 4 oz.	Calculator
30 cc containers - 6	
Larger containers - 6	
Rulers - 6	

Procedure:

1. If you have chosen to let the students continue their experiments on paper towels for a second day, pass out the materials again and allow the children to continue.

2. When most groups have completed testing two or more criteria for towels, ask them to list their findings in order and present their selections for best and worst paper towel to the group. There probably will be considerable variety. Let the students defend their selections.

3. When all presentations have been made, explain to the children that scientists doing experiments work in a manner very similar to the way in which they, the students, have been working. This way is known as "Experimental Method."

4. Introduce Experimental Method step by step. Step 1 is "Finding a problem to investigate."

(Question): 5. "What problem did you investigate?"

Step 2 is "Formulate a hypothesis." Explain to the students that although they did not verbally state a hypothesis, they were operating under the assumption that some towels are better than others. If all brands were alike, there would be no "best."

Step 3 is "Follow a procedure."

(Question): 6. Ask, "What procedure did you follow?" Allow each group some input.

Step 4 is "Collecting data."

7. Ask, "What data did you collect?" (Most of the students will have found out "How many" or "How far.")

Step 5 is "Interpreting Data."

EXPERIMENTAL METHOD

Scientists follow a certain procedure when they do experiments. There are several stages to this process.

1. Finding a problem to investigate. It often starts with "I wonder" in a scientist's mind.

2. Formulating a hypothesis - stating a science problem in such a way that the scientist can study it.

3. Procedure - telling exactly what you did during the experiment.

4. Collecting data - getting all the information you want from your experiment.

5. Interpreting data - figuring out what to do with all those members and facts.

6. Drawing conclusions - analyzing all the facts and figures to determine what they mean - getting an answer to the original problem.

Other skills scientists use:

1. Observing
2. Classifying
3. Using numbers
4. Measuring
5. Predicting
6. Communicating

LESSON III WHICH IS THE BEST PAPER TOWEL - Conclusion (continued)

8. Ask, "What did you do with your numbers after you had recorded them?

   Step 6 is "Drawing a Conclusion, or getting an answer to the problem."

9. Ask, "What was your conclusion?"

Procedure:

10. Point out to the students that they intuitively use experimental method, and that it is a logical way of doing scientific work.

QUIZ

1. Rewrite the following in the correct order:

A. Collecting data	1. _____
B. Stating a hypothesis	2. _____
C. Interpreting data	3. _____
D. Finding a problem to investigate	4. _____
E. Drawing a conclusion	5. _____
F. Following a procedure	6. _____

Using the answers from above, tell which part of the experiment each is. The experiment is in scrambled order.

A. Five children liked Swiss Chard, ten didn't, and 25 had never eaten it. _____

B. Swiss Chard may not be popular _____

C. I called 40 children on the phone or asked them at school if they liked Swiss Chard. I wrote down their responses on a chart.

_____

D.
$$40 \overline{)5.00}^{.125} = 12.5\% \text{ liked Swiss Chard}$$

$$40 \overline{)10.00}^{.25} = 25\% \text{ didn't like Swiss Chard}$$

$$40 \overline{)25.00}^{.625} = 62.5\% \text{ had never eaten Swiss Chard}$$

_____

E. More children didn't like Swiss Chard than liked it, but most had never eaten it. _____

F. I wonder if any children like Swiss Chard? _____

LESSON IV MELTING ICE

Concept:

1. To gain an understanding of elapsed time.

2. To recognize some of the many variables that influences melting rates.

Materials:

KIT	NON-KIT
36 30 cc cups of ice Styrofoam tray Cooler	Clock with second hand

Advance Preparation: At least 24 hours before class time, prepare 36 ice cubes in the following way: Fill 12 30 cc cups to the 10 cc mark. Fill 12 30 cc cups to the 20 cc mark, and fill 12 of the cups to the 30 cc mark. Set them on a tray and freeze them solidly. Try to keep them solidly frozen up to class time by storing in a styrofoam cooler or ice bucket. Do not remove them from plastic cups. However, have the students return all cups to you for reuse.

Procedure:

1. Arrange for the class to work in pairs. Pass out two sizes of cubes to each pair.

(Lead-Off Question)

2. Ask, "How long will it take for the ice cubes to melt in their containers?"

Procedure:

3. Record predictions in 3 columns. 10, 20, and 30 cc's.

4. Ask, "How can we keep track of melting time?"

5. Ask, "How should the ice cubes be treated during melting time? What might happen if you held an ice cube in your hand?" Use the term "variable" to explain the different things that might be done to ice cubes that may influence melting time. Encourage children to observe the ice cubes without handling them.

6. The following table suggests the probable range of melting times. Because of the length of time involved, you may wish to assign other work while students wait for the ice cubes to melt completely.

Volume of Water Used to Prepare Ice	Time Required to Melt All Ice in Approximately 70° F
10 cc	60-75 minutes
20 cc	90-105 minutes
30 cc	105-125 minutes

Are you surprised that half as much ice takes more than half as long to melt?

An optional lesson on thermometer reading follows - it could be utilized here while waiting for ice to melt.

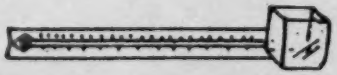
A. What is the temperature of your hand? Use your thermometer in two different ways.

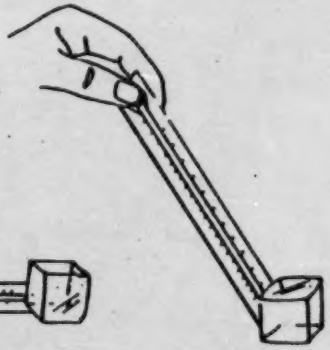
B. What is the temperature of the air? Measure it in three places.

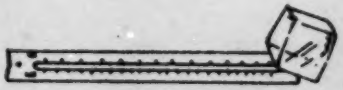
Place_____ Place_____ Place_____

Temperature_____ Temperature_____ Temperature_____

C. What is the temperature of an ice cube? Use your thermometer in several different ways. Describe what you find out.

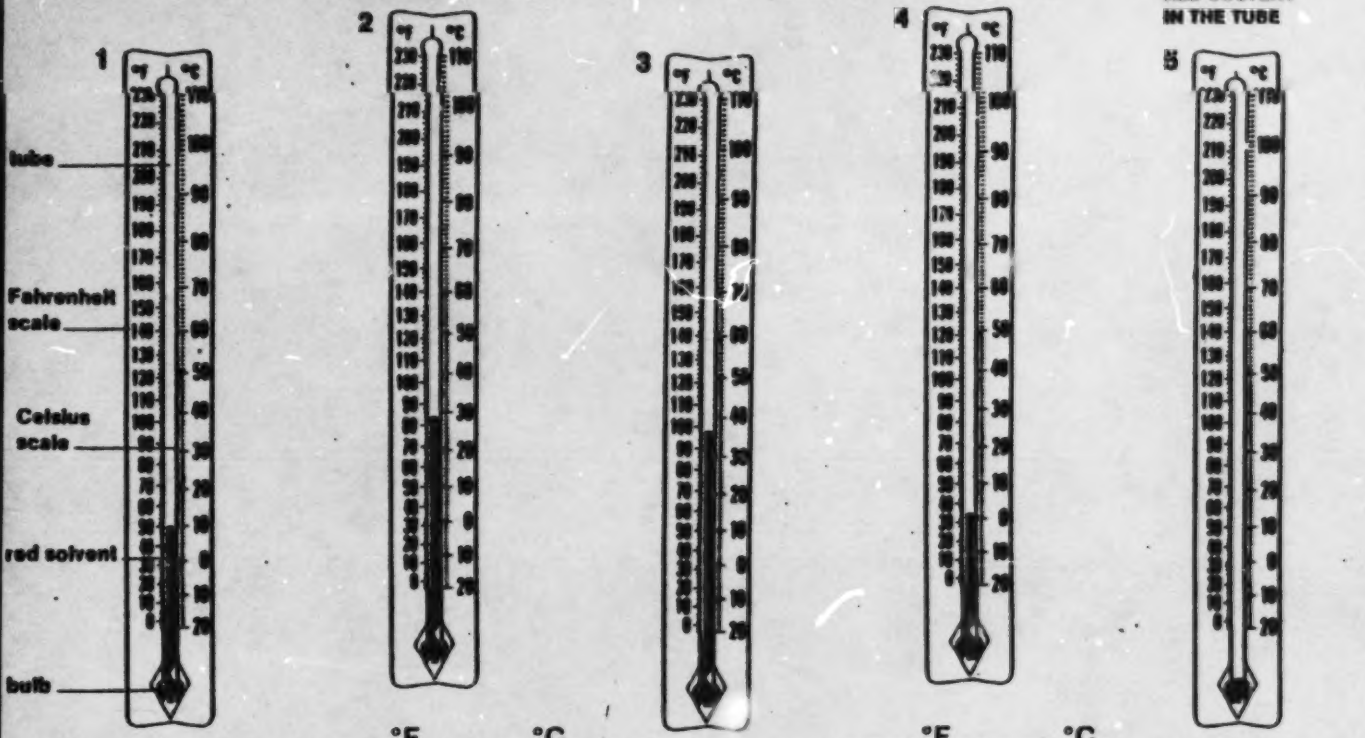






Write the Celsius and Fahrenheit degrees under each picture.

DRAW THE RED SOLVENT IN THE TUBE



_____°F _____°C

_____°F _____°C

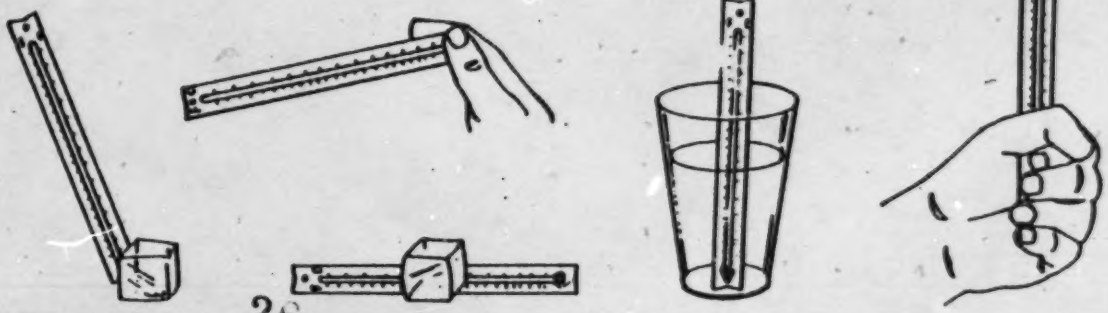
_____°F _____°C

_____°F _____°C

_____°F _____°C

B. Draw lines from the names to the objects whose temperatures are being measured.

hand
air
water
thumb
ice cube



LESSON V — MAKING AN ICE CUBE MELT FASTER THAN IT DOES IN AIR

Concept: There are several ways students can find to melt ice faster than it does in air. Identification of variables.

Materials:

KIT	NON-KIT
40 30 cc cups of ice	Hammers
Styrofoam tray	Hot plate
Plastic container - 6	Books
Baggies - 18	
Stir sticks - 18	

Advance Preparation: Freeze at least 40 30 cc ice cubes before class.

(Lead-off Question)

1. Ask, "How would you make an ice cube melt faster than in air?" List children's suggestions on the board.

Procedure:

2. After the children have listed a number of possibilities, give them an opportunity to try out some of their ideas. Make sure the children remove the ice from the containers before they start and return containers to you. During this very lively activity you may see students smashing ice with hammers, books, or shores, chewing on ice cubes, running water on them, etc. Encourage the children to compare methods afterwards.

3. Ask, "Is there anything about the results that surprises you?"

4. Ask, "Is there a best, fastest, way to melt ice?"

5. Ask, "Can you think of any new, even faster methods?"

6. Ask, "In all the experiments you did today, should you have used ice cubes identical with those you melted in air?"

LESSON VI INVESTIGATING VARIABLES THAT INFLUENCE ICE CUBE MELTING TIME

Concept: Many variables influence ice cube melting time. Utilizing experimental method and controlling variables, factors which influence ice cube melting time can be tested.

Materials:

KIT	NON-KIT
At least 60 30 cc's of ice	Clock with second hand
At least 15 20 cc's of ice	Tongue Depressors (for stirring) - 18
At least 15 10 cc's of ice	
At least 15 red pancakes with 30 cc's of ice	
At least 15 red cylinders with 30 cc's of ice	
Styrofoam tray	
Cooler	
Alcohol - 1 pint	
Vinegar - 1 pint	
Salt - 1/2 lb.	
Thermometers - 16	
Various plastic containers 12 large 12 medium 12 small	

Advance Preparation: Freeze at least 60 or 70 30 cc cubes, 15 10 cc's and 15 20 cc's. Also freeze 30 cc's of ice in 15 flat red cylinders and 30 cc's of ice in 15 tall red cylinders.

Procedure:

1. Arrange for children to work in pairs.

(Lead-off Question)

2. Ask, "What are some factors or variables that may influence melting time?" List children's suggestions on the board. These will usually include: temperature of substance ice is in, amount of ice, whether you stir or not, the quantity of water or liquid the ice is in relating to different sized containers, you may have to demonstrate the new red pancake and cylinder 30 cc quantities of ice so they will include the same volume, but different <u>shape</u> of ice.

Procedure:

3. Depending on your time schedule, you may ask the pairs of children each to chose one variable or several to investigate. If you choose several, count on at least one more class period beyond this one. Explain to the children that they should choose <u>one</u> variable at a time to investigate. They should think of their own experiment and then perform it, trying to control the other variables as they do.

4. Hand out a duplicated copy of the following data sheet. The children then must state the thing they are investigating on the data sheet. You must circulate and check them over.

5. Make available to the children all the equipment they may need with their experiments. Suggest that they remove the ice from the plastic cups so that the melting time will not take so long and so that the cups won't be damaged. Instruct the children not to use more than 50 cc's of either alcohol or vinegar in their containers.

6. Circulate among the children and note the problem they are trying to solve. You can observe if they are working methodically and question them in a helpful way if they are disregarding variables.

7. After all groups are completed, ask each to share their findings with the class.

Name _____

DATA SHEET

A. Problem: I wonder if _____

_____ affects the melting time of ice.

B. Hypothesis: _____

may affect the melting time of ice.

C. Procedure: (Tell all the steps you followed in your experiment.)

_____

_____

_____

_____

_____

D. Data: (Tell how long each part of your experiment took to melt.)

_____

_____

_____

_____

_____

E. Conclusion: I found out that _____

_____

_____

_____

_____

_____

IDENTIFYING VARIABLES

WHEN? At end of unit.

WHO? Entire class.

WHAT? Pupils list the variables that affect the outcome of a simple experiment.

HOW LONG? Twenty minutes.

EVALUATION MATERIALS

1 sheet of writing paper - per student
1 cardboard tray containing:
- 1 set of four spheres (glass, wooden, large steel, and small steel)
- 1 pencil
- 1 ruler
- Several small objects (rubber eraser, paper clip, short pencil stub, plastic vial, key,...)

EVALUATION SUGGESTIONS

Distribute sheets of paper and tell your pupils that you will show them an experiment using some of the objects on the tray. Place the pencil in clear view on your demonstration table or desk, lay the ruler across the pencil to make a small see-saw, and invite the children to select one of the small objects to set on one end of the ruler. Then pick up the small steel sphere, hold it about eight inches above the other end of the ruler, and invite volunteers to predict what will happen when you let the sphere drop onto the ruler. Finally, drop the sphere so it hits the ruler, causing the small object to be hurled into the air. Now tell the children to think of all the variables in this experiment that might affect how high the small object is hurled. Write the question, "What variables might affect how high the object is hurled?" on the chalkboard and ask your pupils to list the variables on their papers. Do not accept any oral replies; help the children spell words if they ask for assistance.

CRITERIA

As you read the children's lists, keep in mind these three types of responses:

1. A clear description of a variable ("the weight of the sphere you drop," "the height from which you drop the sphere," "where you place the pencil under the ruler," "the weight of the small object").

2. Evidence of awareness of a variable but no clear description ("if you used the large sphere, it would really bounce," "the ruler might slip off the pencil").

3. Descriptions, names of objects, or other phrases that are not variables ("It bounced six inches," "the sphere," "the ruler," "you might not see how high it goes").

IDENTIFYING VARIABLES

(continued)

Children who listed three or more type 1 items and no type 3 items show a good understanding of variables; five type 1 items represent an excellent achievement. Children who listed several type 2 items have a fair understanding but need more practice describing variables. Children who listed mostly type 3 items do not have an understanding of variables as distinguished from object or interactions. If you are keeping a record of your pupils' achievement on the evaluation profile, mark symbols for the three levels of performance identified here, or use your own recording technique.

TEACHER'S RESOURCE BOOK

FOR

ATOMS AND MOLECULES

GRADE 5

September 1978

Superintendent of Schools
Anchorage School District
4600 DeBarr Road, Anchorage, Alaska 99504
Telephone (907) 333-9561, Extension 231

A Program Development Division Production

ATOMS AND MOLECULES

GRADE 5

FOR A CLASS OF 35

KIT

35 pill boxes with an object sealed in each one
2 bottles corn syrup or molasses (they must be the same kind).
1 box sugar cubes
35 plastic containers
20 thermometers
35 plastic spoons
20 thermometers
35 plastic spoons
85 seltzer tablets
60 styrofoam cups
1 hot plate
120 sheets graph paper
35 colored pencils

NON-KIT

Water at two temperatures
Cafeteria cans
Pot to heat water to 50° C
1 glass or jar

VOCABULARY

ATOM - The smallest particle of an element that still has all the properties of that element.

CHEMICAL CHANGE - Matter changing from one substance to another as a result of a chemical reaction.

COMPOUND - A substance consisting of two or more elements in a chemical combination.

ELEMENT - The simplest form of matter that cannot be broken down further by ordinary means.

GAS - A form of matter that has no definite volume and no definite shape.

HYPOTHESIS - A scientific idea or working theory.

LIQUID - A state of matter that has a definite volume but no definite shape.

MIXTURE - Two or more substances physically combined so that the properties of each substance are not changed.

MOLECULE - The smallest particle of a substance that can exist independently and has all the properties of the substance.

PHYSICAL CHANGE - One in which no change occurs in the chemical composition.

SOLID - A state of matter that has a definite shape and a definite volume.

SOLUTION - A mixture of two substances in a liquid state.

SUSPENSION - The state of a substance when its particles are mixed with but undissolved in a fluid or solid.

VARIABLE - The part of an experiment which is allowed to change in each test or trial.

SUPPLEMENTARY MATERIALS:

FILMS:

F-547 ATOMIC ENERGY - INSIDE THE ATOM, 14 min., color
F-545 EVIDENCE FOR MOLECULES AND ATOMS, 19 min., color
F-117 WORLD OF MOLECULES, 11 min., color

BOOKS:

INSIDE THE ATOM - Asimov (6+)
ALL ABOUT THE ATOM - Freeman
THE STORY OF THE ATOM - Freeman
OUR FRIEND THE ATOM - Haber
BUILDING BLOCKS OF THE UNIVERSE - Asimov (6+)
THE STORY OF CHEMISTRY - Freeman
CRYSTAL MAGIC - David

BOOK SERIES, 5TH GRADE

1974 - PEOPLE CONCEPTS PROCESSES - McGraw-Hill, page 104
1975 - CONCEPTS IN SCIENCE - Harcourt, Brace, Jovanovich, page 115

ATOMS AND MOLECULES

Grade 5

INTRODUCTION:

Chemistry is the study of the composition of matter, the properties of matter and the changes in composition of matter. Needless to say, your children do not have this understanding. More important, there is no reason why they should. However, they do know their world is made up of "stuff" and when you put "different stuff" together something new might be made. They have observed mixing "stuff" such as milk and flour, water and plaster paris; a candle burning; the fizz when a bottle of pop is opened. These are all examples of matter undergoing change. In this unit of work the children will be asked to mix materials together and really look at what happens. From this experience they will gain early understandings of the things matter is composed of.

The unit is divided into 5 lessons which will allow your students to observe, collect data, discuss and begin to understand that matter (stuff) is made of small particles which cannot be individually seen, but can be worked with just the same. Your students will be able to relate changes in chemical and physical properties and, perhaps most important, will be involved in investigating science.

RATIONALE:

The conceptual threads promoted in this unit of work extend those gained by the students at grade 4. You may want to take a look at what was done at grade 4 and what will occur at grade 6. Your principal has the units so feel free to take a look. Perhaps you may find that you want to use parts of the 4th grade Atoms and Molecules unit again, as review. Check with the other teachers to see what they have done. If you won't be repeating too much, move full speed ahead.

The terms "variable", "variables held constant", and "hypothesis", are reviewed in this unit. They are introduced and utilized in another level 5 unit, "Experiments With Paper and With Ice Cubes".

SCHEDULE:

Your involvement is with the children and not of handling materials any more than is absolutely necessary. The more you can promote student involvement in setting up - running - taking down the experiments, the greater the learning.

The unit is divided into 5 lessons which are designed to allow your children to observe, collect data, discuss and begin to intuitively understand the nature of matter. Each lesson will take 30-45 minutes to complete if you use a pre-laboratory discussion experimentation - post-laboratory discussion sequence. Leading questions are given throughout each lesson so that your children might be stimulated to do some additional experimentation. If you allow for the added discovery, the unit of work will probably last the full three week request limit.

BACKGROUND INFORMATION:

Now for some facts for you. These are included only as specific information to allow you to become more familiar with atoms and molecules. The information is not essential for the success of the unit!

PROPERTIES OF MATTER:

All materials have three characteristics: (1) They take up space (have volume), (2) they have weight, (3) they are all made up of atoms and molecules. All substances that have these three characteristics are called "matter". Wood, water, and air are all matter because they all take up space, have weight and are made of atoms and molecules. Because molecules have weight and volume, even though they are very small, matter also has weight and volume.

STATES OF MATTER:

Matter is found in three forms or states. These are solid, liquid and gas. A solid has a definite volume and shape of its own. A liquid has a definite volume but no shape of its own (it takes the shape of its container). A gas has no definite volume and no shape of its own. A liquid or a gas is often called a fluid, which is any material that flows.

MOLECULAR THEORY:

This theory contains four main ideas: (1) all matter is made up of molecules. (2) there are spaces between molecules, (3) molecules are always moving, (4) molecules attract each other.

All matter is made of molecules and there are spaces between these molecules. The spaces between the molecules of a liquid are larger than the spaces between a solid. The spaces between the molecules of a gas are larger than those between the molecules of a liquid. It is hard to imagine spaces between the molecules of a solid, but if a piece of gold is put into a dish of mercury (silvery liquid), the mercury will go into the gold - the molecules of the mercury will slide in between the molecules of the gold.

Molecules are always moving. Each molecule in a solid vibrates around a fixed point. The molecules in liquids and gases move at random in all directions. The molecules in gases travel faster and farther than those in liquids.

Molecules attract each other. The force with which they do attract each other depends upon what kind of molecule they are, and also depends on how close they are to each other. Two molecules attract each other much more strongly when they are close together than when they are far apart. So molecules in a solid attract each other more strongly than those in a liquid, and molecules in a gas are so far apart they hardly attract each other at all.

ATOMIC THEORY:

This theory states that all molecules are made up of small particles called atoms, and atoms within a molecule attract each other very strongly.

The attraction between atoms in a molecule is much greater than that between molecules within a substance. For the attraction between atoms to be broken, a chemical reaction (accompanied with some form of energy) must occur.

SOLUTIONS AND SUSPENSIONS:

A solution is a mixture of two or more materials evenly mixed together whose particles are separate molecules. Most solutions are made by dissolving a solid (solute) into a liquid (solvent), an example would be sugar in water. Some solutions are liquids in liquids (water in vinegar), gases in liquids (carbon dioxide in water or pop), and gases in gases (a mixture of oxygen, nitrogen and carbon dioxide). Solutions have three characteristics: (1) The particles of the materials are separate molecules and cannot be seen even with a powerful microscope. (2) The particles in a solution are evenly spread through all parts of the solution and will never rise to the top or sink to the bottom. (3) The dissolved material cannot be removed by filtering the solution. The material doing the dissolving is called the solvent. The material being dissolved is called the solute. If a material will dissolve in another it is said to be soluble. If it is not able to be dissolved in the other material (oil in water) it is said to be insoluble. Salt is soluble in water, but insoluble in alcohol. Salt is the solute if water is the solvent.

The molecular theory explains what happens when materials form solutions. When any material is dissolved, it separates into its molecules. At first these are fairly close together because they attract each other. But the molecules of the solvent also attract them. All the molecules keep moving and bouncing about. The molecules of the dissolved material spread into the spaces between the molecules of the solvent. After awhile, all the molecules become evenly mixed and stay that way. In a solution such as sugar and water, the particles of sugar are separate molecules. The solution is clear because the molecules are much too small to be seen. They are also small enough to pass through a filter that the water molecules will go through.

Why some materials are insoluble in other materials can also be explained by the molecular theory. There is very little attraction between molecules of oil and water. When oil and water are mixed, the oil molecules tend to stay together and do not spread among the water molecules. By strongly shaking such a mixture, you can separate the oil into tiny clumps of oil molecules spread through the water. But after the mixture is allowed to stand awhile, the oil molecules will attract each other and come together and form a separate layer.

TEMPERATURE AND PRESSURE:

Molecules are arranged differently in each state of matter. The molecules of a solid are very close together, and the attraction between is quite strong. They move about a fixed point because they are held so firmly. The molecules of a liquid are usually farther apart, and the attraction between them is very weak. They move or dart around and are scarcely held together.

When any material is heated, the molecules absorb the heat energy and start to move around faster than they normally did. If the material is heated enough, the molecules will be moving so hard and fast that they jerk away from each other and escape into the air (evaporation). As heat is added, the molecules move faster and farther apart and the material expands. If the material is cooled, the molecules slow down and move closer together and the material contracts.

The pressure a material exerts is due to the bombardment of the molecules on the side of the container that holds the material (for example air). If the air is heated, the molecules bounce around faster and hit the side of the container harder and more often, causing the pressure to increase on the inside of the container. If the air is cooled, the molecules slow down and hit the side of the container less often and the pressure is decreased.

Because there are large spaces between air molecules, air can be compressed or expanded fairly easily. If you put pressure on air inside an airtight piston, the molecules will be pushed closer together and this will cause the pressure on the inside of the container to increase (more molecules hitting the side of the container). If the molecules are pulled apart, the pressure will decrease.

ELEMENTS AND COMPOUNDS:

Every one of the many materials that we know about is different from every other material in one or more ways. Yet all these materials can be classified into three categories: ELEMENTS, COMPOUNDS, MIXTURES. An element is a material that cannot be changed into simpler materials by chemical means. It is made up of only one kind of atom and if broken down into smaller units would only yield parts of atoms (nucleus, electrons, etc.). There are just over 100 different kinds of elements which also means there are just over 100 different kinds of atoms. Iron, copper, carbon, gold, hydrogen and oxygen are examples of elements.

Materials are made of molecules which in turn are made of atoms. An atom is the smallest particle of an element that can exist as that element. For example, an atom of iron is the smallest particle of iron that there can be. A molecule of an element is made of one or more atoms of the same kind. Most elements have only one atom in the molecule. Some of these are iron, copper, aluminum, silver and carbon. So, in these elements, the atom and the molecule are the same. But in some elements that are gases, the molecules contain two atoms of the same kind. There are two atoms of oxygen in every oxygen molecule. Other examples are hydrogen, chlorine and nitrogen. These molecules are called diatomic.

A compound is a material made of two or more elements jointed together, or combined so they cannot be separated unless a chemical reaction occurs. One way to tell the difference between an element and compound is to see if the material can be separated into two or more different materials. Some ways this can be done is to heat the material, run an electrical current through the material, or add some other substance to the material and cause a chemical reaction. An example is as follows: Mercuric oxide is a compound of two elements, mercury (a silver-colored liquid) and oxygen (a colorless, odorless gas). When mercury and oxygen combine they form a red powder which is mercuric oxide. When the red powder is heated, it breaks up into its elements, oxygen is given off and mercury is left.

Mercuric oxide and table salt (sodium chloride - NaCl) are made of two elements. Water (H_2O), hydrochloric acid (HCl) and carbon dioxide (CO_2) are also made of only two kinds of elements. Sugar, alcohol and acetic acid are compounds that each have three different kinds of elements in the molecules. Alum, baking soda and some soaps have four elements in them. And there are some compounds that have even more elements than just four.

Materials that are not elements or compounds are called mixtures. The molecules in a mixture are intermingled, but they are not chemically combined. Each element keeps its individual property. For example, in a mixture of iron filings and sulfur powder you can see the individual particles of iron and sulfur. If you pass a magnet through the mixture the iron filings will adhere to it. If you add water to the mixture the iron filings will drop to the bottom and the sulfur will float to the top. The parts of this mixture can be separated by physical means. If this mixture were heated, a chemical reaction would occur and the two elements would combine and form a completely different substances - iron sulfide, which is a black material that is not magnetic and will not float on water (its properties have changed from the original materials). The molecule of iron sulfide (which is a compound now) contains one atom of iron and one atom of sulfur (FeS). Air is a mixture of gases, milk is a mixture of fats, water, sugar and other materials, wood, paper, glass, and even your body is a mixture of a variety of elements and compounds.

PHYSICAL AND CHEMICAL CHANGES:

A physical change is a change in which the material changes its size or form but remains the same material with the same properties. The molecules of the material are not changed, only the form, state or shape of the material has changed. For example, water goes through physical changes when it turns to ice or steam, but the molecules of water remain unchanged.

A chemical change is a change in which one material is changed into one or more different materials with different properties than the original material had. The molecules of the first material are changed by a chemical reaction into different molecules.

An example of a chemical change is the burning of sugar which contains carbon, oxygen and hydrogen atoms in the molecule. When energy is added in the form of fire or heat, a chemical reaction occurs and the molecule is split, leaving carbon in the form of charcoal and water vapor is given off.

LESSON I BLACK BOXES

Concept: To identify an object by inference (a reasonable guess based on past experience).

Materials:

KIT	NON-KIT
35 boxes 35 objects	Paper and pencils

* Scientists are not able to see atoms and most molecules because they are too small, but they still are able to know how they look by the way they react with other materials.

* The "black box" method of inquiry is a good way for students to find out that even though they can't see many things, they can tell what they are like or, in some instances, what they are. The students do this by using their senses and relating what they sense to other things they know about.

* The entire atomic theory has been developed from inferences. The atom's structure is inferred from phenomena that can be observed very much in the same way that the identity of the hidden object (in this lesson) can be inferred.

* If you want a more formal lesson, you might consider drawing the following chart on the board for your students to follow:

QUESTION	MANIPULATION	OBSERVATION	ASSUMPTION

Procedure:

1. Before you begin this lesson, check to see if one object is in each box. There should be enough boxes so each student has one.

2. Pass out one box to each student. Caution the student not to open their box!

(Lead-off Question)

3. Ask, "Can you draw a picture of what is in the box?"

4. Indicate to your students that they can do anything they want to the box except (1) open it (2) crush it; (3) dip in water, etc.

5. Needless to say, the noise level in your room will rise for a time. Everyone will try to "shake it to pieces". LET THEM SHAKE! Soon the students will find they can't tell a thing when they shake the box vigorously. At this point suggest that they turn the box different ways.

LESSON I BLACK BOXES (continued)

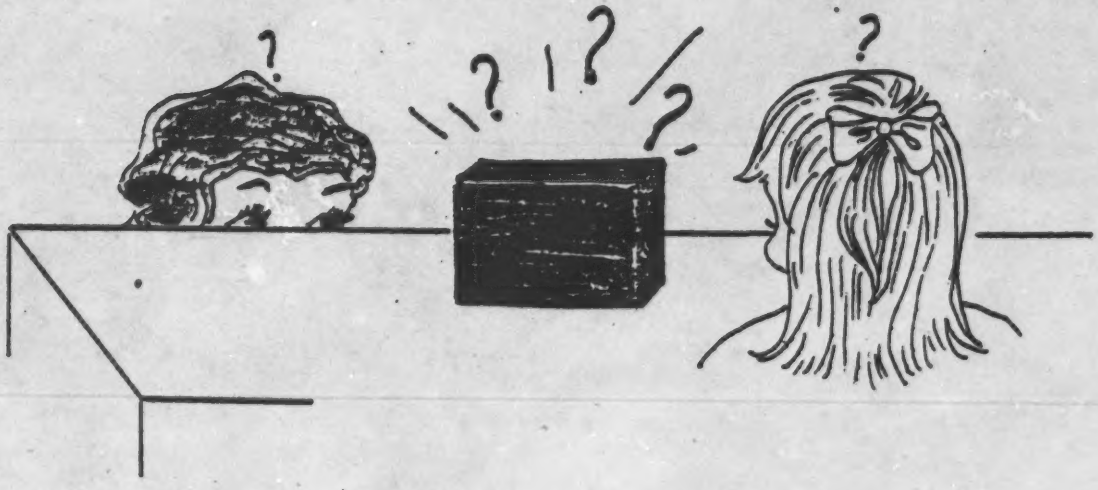
6. The students may not know what the object is, but they can probably draw a pretty good picture of the object. Have them draw what they think the object looks like.

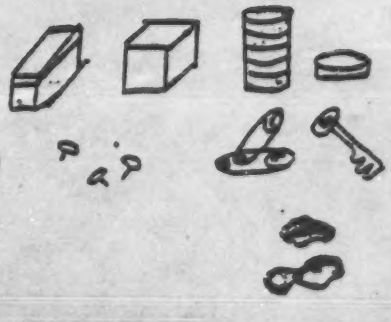
(Follow-up Question)

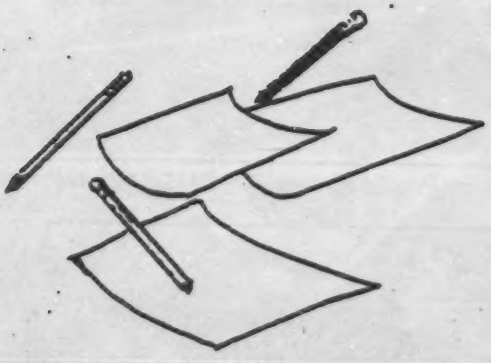
7. After they have drawn their pictures ask,
"What pictures did you draw?"
"How many of you drew the same thing?"
"Can anyone describe the object?"
"What other things might you do to know what the objects look like?" - "Without looking at it?"
"Do you have to see every object to know what it looks like?"

8. This is a fun lesson and can be extended to any hidden objects in the box or a larger box. Perhaps your students will want to try some other materials. Practice in inferring is a valuable exercise.

9. Some properties you might try to stress are: (1) size, (2) hardness, (3) shape, (4) material composition, e.g., like metal, like glass, like rubber, like rock, etc.







LESSON II GLUGS, FIZZLES AND SWEETS

Concept: To construct a hypothesis to explain the effect of temperature on dissolving time.

To demonstrate ways to hold variables constant.

To demonstrate ways to manipulate variables.

Materials:

KIT	NON-KIT
2 bottles corn syrup	Water at two temperatures
1 box sugar cubes	Cafeteria cans
35 plastic containers	
17 thermometers	
35 plastic spoons	

* Lessons II-V can be run as individual lessons or as part of one continuous series of activities.

* Temperature is generally an important variable when measuring the time it takes for a product to be formed by mixing two or more substances. For example, sugar dissolves more rapidly in hot water than cold water. Foods spoil more quickly at hot temperatures.

* Your students will have a chance to observe and record data from several experiments dealing with the effect of temperature on the dissolving time of substances.

Advance Preparation: The day before you begin this laboratory lesson, place a bottle of the corn syrup or molasses (whichever is provided in the kit) in the kitchen refrigerator at your school. Leave the second bottle at room temperature. You will need to use hot water for this lesson and should locate a source.

* It will be helpful to have the materials needed for this lesson out on tables in two different places in your room.

Procedure:

1. Place two bottles of corn syrup (or molasses), one cold and one at room temperature, in front of the class.

(Lead-off Question)

2. Ask, "Do you see any difference between the two?" Accept all statements!

3. Open both bottles. Pour a little of one into a plastic container and a little of the other into another plastic container. Ask, "What did you observe?" If no one hits on the words faster or thinner or the like, repeat the demonstration.

4. Ask, "What may have been done to the two bottles to cause the difference?"

   Students could answer in at least three ways:

   a. Water was added to one.
   b. One was cooled.
   c. One was heated.

5. Hold up two thermometers and ask two students to measure the temperature of the liquids.

(Follow-up Question)

6. Put both temperature readings on the board. Ask, "How do you interpret the data you have obtained?"

   Students should identify the liquid which pours most rapidly as being warmer than the other.

7. Divide your class into teams of two. Have each team obtain two plastic containers and two whole sugar cubes. Next, they are to obtain water at two different temperatures - one for each container. There should be approximately equal amounts of water in each container. 40° to 50° C water in one and 15° to 20° C water in the other will work well (hot and cold tap water). Last, they should obtain one thermometer and two plastic spoons.

8. Have each team measure the temperature of water in each plastic container and record the results. One possible chart you might suggest is as follows: Example values have been put on chart for your information.

Temperature in degrees Celsius	Trial Number	Time for substance to dissolve, in seconds	Average of all values, in seconds
20	1 2 3	82 80 78	80
40	1 2 3	32 28 33	31

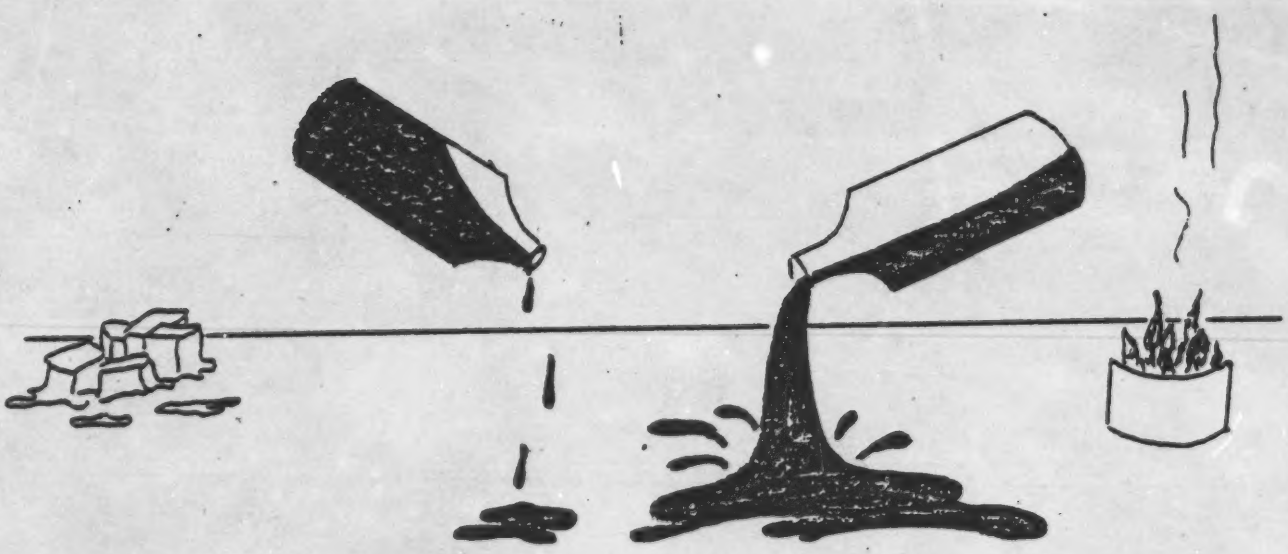
9. Have each team place a sugar cube in each container and stir slowly as they time the dissolving sugar.

* It will be necessary to review how an average value is obtained - add values for each trial run, then divide total by the number of trial runs.

(Follow-up Question) 10. Once the students have filled-in their chart, record the average value from each group on the blackboard. Ask, "What do you think your observations suggest about the effect on the dissolving time.

* It is important to place all average values on the board since individual results may vary. This doesn't mean that any team is wrong. Rather, it will show that each team was running a slightly different experiment. Once the values are on the board, the trend will become apparent.

* The answers students give to the question asked in step number 10 are referred to as a Hypothesis. You might want to use this term with the students.



LESSON III PREDICTING FIZZLING TIME

Concept: To construct a hypothesis to explain the effect of temperature on dissolving time.

To control variable.

To graph results.

* The students probably have had little prior experience in relating temperature to dissolving time. However, several will probably state that their hypothesis from Lesson I will hold for other substances.

* It might be wise to review what a variable is since this lesson starts with this word. Simply stated, variables are those things you manipulate or control in an experiment.

Materials:

KIT	NON-KIT
45 seltzer tablets	Hot and cold water
20 styrofoam cups	Pot to heat water
20 thermometers	
1 hot plate	
40 graph paper	

Procedure:

(Lead-off Question)

1. Ask, "Does your hypothesis about the dissolving time of sugar apply to other substances as well?"

   * The students will probably agree that it does.

2. Tell the students that they are going to find out whether their hypotheses hold true or not.

3. Ask, "What variables must be held constant in order to study the effect of temperature on the dissolving time of seltzer tablets.

   Possible answers include:

   a. Definition of the point at which the table is dissolved.
   b. Kind of tablet used
   c. Volume of water
   d. Movement or stillness of the water

4. Ask, "In this experiment, what variable will you manipulate?" (Temperature of water)

LESSON III PREDICTING FIZZLING TIME (continued)

5. Have each team of two students obtain a container, thermometer and two seltzer tablets. Assign each team a particular temperature - either 20° or 40° C at which to perform their tests. Faucet water (hot and cold) will generally work.

* The sequence students might use to time dissolving includes reading the thermometer, dropping the tablet and observing, timing and recording. For best results, the tablet should not be touched during the dissolving period.

6. Each team should run the experiment twice. USE FRESH WATER ON SECOND RUN.

7. A recording chart similar to that shown in Lesson II can be used by the students. When students have determined the mean number of seconds to dissolve the seltzer tablets you should have each team put the results on the board. The following chart can be used. Possible answers are shown here for your information.

Temperature in degrees Celsius	Group Number	Time for tablet to dissolve in seconds			Mean of all values in seconds
		Trial 1	Trial 2	Mean	
20	1	82	85	84	80
	2	75	80	78	
	3	80	75	78	
	4	85	75	80	
40	5	32	29	31	31
	6	29	33	31	
	7	25	30	28	
	8	28	40	34	

(Follow-up Question) 8. Ask, "What is the range of the measurements of dissolving time at 20° C?"

* Your students may not understand the word range. If so, take a minute to show them three or four increasing numbers and then explain that the extremes represent the range of numbers. The number is obtained by subtracting the lowest number from the highest.

9. Ask, "What was the shortest dissolving time of the seltzer tablet at 20° C?" (In the example the answer is 75 seconds.) "What was the longest dissolving time?" (85 seconds) "What is the range of this set of measurements?" (10 seconds)

10. Ask, "What do you think the range tells us about our data?"

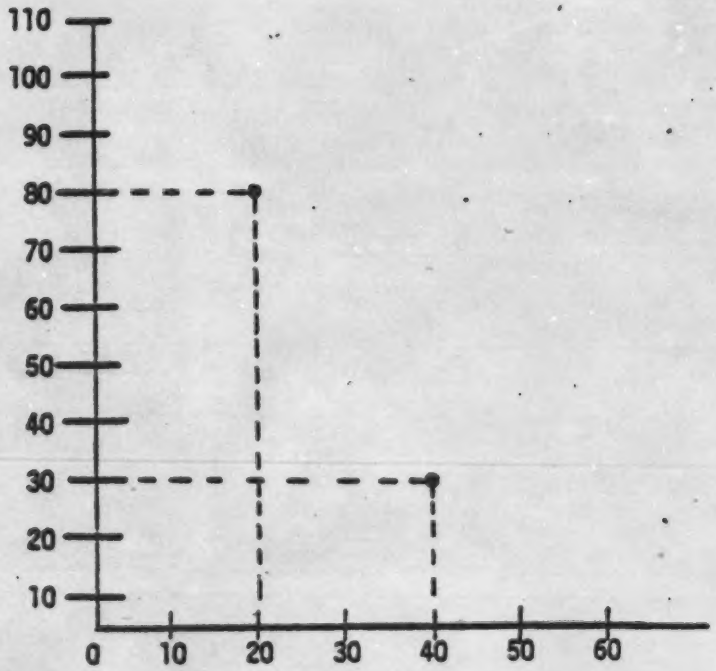
11. Next, repeat the same questions for the 40° C experiments.

12. After obtaining this data ask, "Is the reaction time shorter or longer with an increase in temperature?" (shorter) "How do the data demonstrate this?" (Less time at 40° C than 20° C)

13. Ask, "Does the data support your original hypothesis?"

14. Ask, "Could you use the data to predict other dissolving times?" (Yes) "What would be the easiest way to predict dissolving time?"

* Students may or may not come up with the suggestion to graph the results. If they do not, you should suggest it! Draw a simple graph on the board. One such graph might look as follows:



15. Pass out graph paper to each student and ask the students to plot the dissolving time and the temperature of their graphs. Have them use the graph to predict dissolving times for 30°, 10° and 50° C.

* Students should mark these values on their graphs with the symbol P, indicating that these are predictions.

16. A discussion of the students' predictions should follow the graphing proceedings.

* There may be some disagreement between students. This can be resolved by asking different students to demonstrate how they arrived at their conclusions.

LESSON IV. HOW GOOD ARE YOUR PREDICTIONS?

Concepts: To support hypotheses with experiment evidence.

To generalize from experimental data.

To control variables.

Materials:

KIT	NON-KIT
20 seltzer tablets	Hot and cold water
20 styrofoam cups	Pots and containers
20 thermometers	(Cafeteria cans)
1 hot plate	
40 graph paper	
35 colored pencils	

* You will note that the temperature values, when graphed in the last experiment, were placed along the horizontal axis. Traditionally those variables we control are placed along the horizontal axis. These are called the dependent variables. The variables that we do not change are placed on the vertical axis. These are called the independent variables.

* In the previous lesson, your students were asked to predict dissolving time at 30°, 10° and 50° C. In this experiment they will test their predictions. Two or more teams should be assigned to each temperature.

Procedure:

1. State, "Today you are going to have a chance to test your predictions about dissolving time at 30°, 10° and 50° C.

2. Assign different teams to the experiments at the different temperatures. Have the teams run the experiment.

(Discussion Question)

3. After the teams have performed the experiment, have a recorder for each team enter the results in a table on the board (a recording chart which can be used is shown below). Have each student compare his predictions with the actual results.

   Ask, "Were your predictions satisfactory?"

* Dissolving time predictions for temperatures above 40° and below 20° C will most likely be too low.

   Ask, "Do the data support the hypothesis you were testing?" (They probably do not).

4. Ask, "Why weren't your predictions more accurate?"

   Call attention to:

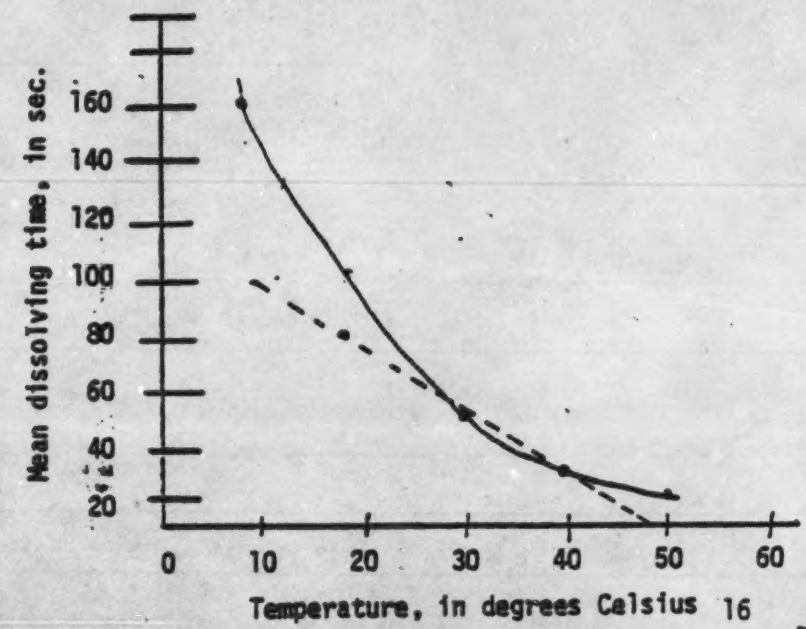
   a. Dissolving times were taken originally at two temperatures.
   b. Students didn't have enough information.
   c. The line on the graph should have been a curve instead of a straight line.

   Possible dissolving times for different temperatures are shown on the table below.

Temperature in degrees Celsius	Group Number	Time for tablet to dissolve in seconds		
		Trial 1	Trial 2	Mean
10	1	180	165	163
	2	145	160	
20				80
30	3	45	50	
	4	45	42	46
40				31
50	5	23	21	
	6	23	25	23

5. Ask each student to plot the data for 30°, 10° and 50° C on the graph he made in the last lesson. USE A DIFFERENT COLORED PENCIL!

6. Suggest that each student try to connect all the points with a curve. Next have them draw a dotted straight line between 20° and 40° C. An example of this is shown below.



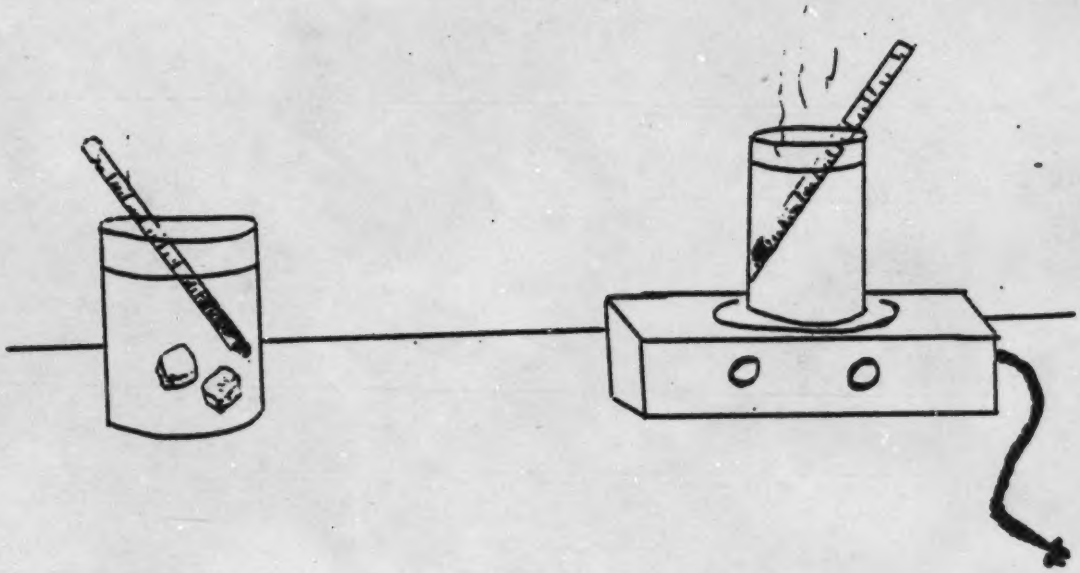
16

LESSON IV HOW GOOD ARE YOUR PREDICTIONS? (continued)

7. Ask, "Why was your prediction at 30° C too great? (Because a straight line was drawn between 20° and 40° C rather than curved line.)

   Ask, "Did we have enough information to decide whether the line between 20° and 40° should be straight or curved?" (No)

   Ask, "What might you have predicted for a dissolving time at 20° C if we first measured 10° and 30° C?" (On the sample shown it would have been approximately 104 seconds rather than 80 seconds).



LESSON V **A FINAL HYPOTHESIS**

Concept: To generalize from experimental data.
To interpret data.

Materials:

KIT	NON-KIT
As in lesson IV	1 glass

* In this lesson you will lead the students to the generalization that the higher the temperature the smaller the change in reaction time. This is in addition to the original hypothesis that reaction time decreases as the temperature increases.

Procedure:

1. Ask the students to prepare a chart of <u>their</u> <u>data</u> similar to the chart below.

Temperature in degrees Celsius	Mean dissolving time, in seconds	Change in dissolving time, in seconds
10	163	83
20	80	
30	46	34
40	31	15
50	23	8

(Lead-off Question)

2. Ask, "Does a 10° C increase in temperature always cause the same reaction time?" (No)

   Ask, "How does the change in reaction vary with temperature?"

   * The higher the temperature, the smaller the change in reaction time.

(Follow-up Question)

3. Ask, "Can you predict the dissolving time for 60° C?" (Approximately 20 seconds according to the data shown.)

4. You might want someone to try it as an optional experiment.

5. As another optional experiment you might want to have one group drop a tablet in a <u>glass</u> of water, have the entire class measure the dissolving time and <u>predict the temperature of the water</u>.

PLANTS AND ANIMALS: ECOSYSTEMS

GRADE 5

PLANTS AND ANIMAL 5TH GRADE

KIT

35 Magnifying glasses
70 Golf tees
17 Plastic rulers
4 Thermometers
3 Stereoscopes - (To be ordered for the specific lesson - not to be in the classroom during the whole 3 weeks)
10 Petri dishes
10 Plastic sheets
1 Aluminum sheet

NON-KIT

Guide for plant identification
Pill bottle
Cheese cloth (small amount)
Bright light source
Funnel or cone
Alcohol
Potatoes
Dish — Optional
Gravel

PLANTS AND ANIMALS: ECOSYSTEMS

GRADE 5

SUPPLEMENTARY MATERIALS LIST

There are a number of films which can be used to supplement this unit of work. These can be requested from A.V. Services. Additional films are available through the U.S. Fish and Wildlife Service and the Alaska Fish and Game.

FILMS

F2040	Cry of the Marsh
F264	Life in the Ocean (1955)
F95	Aquarium Wonderland (1955)
F2228	Ecology of the Arctic - 16 min.
F2420	Life in the Tundra - 14 min. - Color
F1389	Spruce Bog - 23 min.
F1461	Terrarium - 11 min.
F671	Microscopic Life in Soil - 14 min.
F2206	Redwood Forest, Stream, Ocean Beach and Butterfly Trees
F2412	Environment - Everthing Around Us
F2433	What Do They Eat - 5 min.
F2504	Balance of Life and Space Age - 13 min.
F2556	Mayfly - Ecology of an Aquatic Insect - 15 min.
F1405	Lake Titicaca - 22 min.

CLASSROOM SCIENCE READING RESOURCES

Middle Level

TWIST, WIGGLE, AND SQUIRM; a book about earthworms by Pringle 1973

Upper Level

ANIMALS by Fichter 1973

ANIMALS AND THEIR EARS by Earle 1974

ANIMALS THAT HIDE, IMITATE, AND BLUFF by Hess 1970

CARELESS ANIMALS by Graham 1975

CITY LEAVES, CITY TREES by Gallob 1972

CREATURES OF DARKNESS by Waters 1975

DINOSAURS: AND OTHER PREHISTORIC ANIMALS by Geis 1959

DISCOVERING WHAT CRICKETS DO by Simon 1973

DISCOVERING WHAT GERBILS DO by Simon 1971

FOOD YOU EAT by Marr 1973

YOUNG READERS EDITION OF THE LIFE NATURE LIBRARY

ANIMAL BEHAVIOR by Tinbergen 1968, 1970

BIRDS by Peterson 1967, 1970

DESERT by Leopold 1967, 1970

EARLY MAN by Howell 1968, 1970

EARTH by Beiser 1968, 1970

EVOLUTION by Moore 1968, 1970

FISHES by Ommanney 1967, 1970

MAMMALS by Carrington 1967, 1970

PRIMATES by Zimeri 1968, 1970

REPTILES by Carr 1967, 1970

SEA by Engel 1970

UNIVERSE by Bergamini 1968, 1970

CLASSROOM SCIENCE READING RESOURCES

LIFE OF BIRDS by Burton 1972

LIFE OF FISHES by Burton 1972

LIFE OF INSECTS by Burton 1972

LIFE OF MEAT EATERS by Burton 1973

OUR SIX-LEGGED FRIENDS AND ALLIES by Simon 1971

PETS IN A JAR by Simon 1975

REPTILES AND AMPHIBIANS by Warner 1974

SENSE ORGANS by Silverstein 1971

BOOK SERIES:

1974 PEOPLE CONCEPTS PROCESSES - McGraw-Hill

Pages 26-55
136-147
280-289
300-312

PLANTS AND ANIMALS ECOSYSTEMS

GRADE 5

INTRODUCTION:

Wherever plants and animals live, they form part of special communities, called Ecosystems. Each system differs from the next. It is the study of one or more ecosystems which constitutes this unit of work.

Have you ever stood in a grove of trees and thought about the things that go together to make up the beauty? What are some of the things? Naturally, trees are there, but they are not alone. Perhaps you will find shrubs and vines and ferns and mosses, and mushrooms and grass, all growing beneath the trees. Perhaps you will see an insect flying around - perhaps one crawling around. Do you see birds or signs of birds? This story can go on and on. Yet, the multitude of organisms don't just live there - they are the environment. Each living organism and non-living thing plays a role in maintaining an intricate balance. The system is dynamic and it is always changing.

Each plant and animal depends upon each other. Each plant and each animal has certain requirements - such as water, air, sunlight - that must be met for its survival. And a slight change to any environment will bring about changes to the organisms living there.

Starting with a school yard ecosystem allows your children to observe, measure, express ideas, classify, and experiment with the whole of biology. Most important, the school yard ecosystem will allow for them to see and feel the fine balance which is in nature and the part man plays in its control.

TEACHER BACKGROUND:

Properties of Living Things

Life is a condition which is found in a complex arrangement of chemical substances occurring in all living things. Living things grow and reproduce. Many living things move about.

Life is a condition of protoplasm. Protoplasm is the living substances found in all living cells. It is a complex group or systems of substances. The activities of protoplasm are what we might call the activities of life.

All living things come from other living things. They inherit size and from from their parents. In other words, <u>like produces like</u>. Living things have a determined life span. No form of life can exist indefinitely. Living things maintain constant activity. Life activity does not refer only to visible signs of life, such as moving around, but to the activity of the protoplasm in the plant or animal. The activities of plants and animals is called their life functions, or life processes. These life processes or functions are as follows: 1) ingestion of food substances, 2) digestion, 3) absorption, 4) respiration, 5) assimilation, 6) excretion, 7) motion, 8) secretion, 9) sensitivity, and 10) reproduction.

Living things have a critical relationship with their environment. Factors such as temperature, rainfall, humidity, or water vapor in the air, winds, and air currents, soil conditions, and variations in the surface of the earth have a direct influence on the life of different areas. As these conditions vary, plants and animals in the region vary. Desert animals and plants could not survive in a swampy area.

Living things respond to the conditions around them. Only living protoplasm has the property of reacting to its environment. Non-living things may be influenced by the environment, as water freezes and becomes ice, but protoplasm is the only substance which is capable of responding to a stimulum. Living things must reproduce. Reproduction is the ability to produce new living things that are similar to the parents. Living things have a survival problem. Plants and animals face a constant struggle for life. Much of this struggle centers around requirements for life. If the living things cannot adapt to changes in their environment, they must move to a different area that satisfies their needs, or they will die.

Necessities of Life

All living things must be able to carry on their life processes or they will die. To carry on these processes, they require certain conditions in their environment. These conditions of the environment are called factors of the environment and are divided into two groups: physical factors and biotic factors. Soil conditions, temperature, light, water, atmospheric conditions and topography of the region are some physical factors. All living things of any area are considered the biotic factors.

Soil is a basic factor of the environment. Soil varies greatly in different regions. The plants and animals that the soil supports vary accordingly.

Temperature is a controlling factor of the environment. All temperature changes affect the plants and animals of a region. Any organism must be able to withstand the slight variations of day and night as well as seasonal changes of that region.

Water is essential for all life. To meet their critical water needs, plants and animals range from organisms living in a complete water environment to those thriving in the sun-parched deserts. Each organism has adapted to the specific area in order to survive there.

Light is a critical factor in the environment. Light is essential to all green plants in food-making. Some plants, though, have adapted to living without light and are what we call parasites. Some animals and some microscopic organisms also have adapted to living without light. Careful study of the organisms that live in darkness has revealed that they depend indirectly on light for existence. Light conditions vary from place to place just as temperatures do. Plants and animals have adapted to their environment and thus to the variations of light.

The atmosphere of an area is another factor of that environment. Air and water are both places that must meet the need (oxygen supply) of the plants and animals of that area. Air pressure, winds and currents, humidity, as well as oxygen supply, are things that might vary from region to region.

Topography is the physical features of the earth. These features change very slowly, but have a great affect on the living things of a region. Changes in the area also change the plant and animal communities of that area.

Biotic factors include all plants and animals of a given area. The biotic factors of an area are determined by the physical factors of that area.

Ecology

Ecology is the study of organisms and their relationship to their environment. The environment is all living and non-living things that act upon that organisms. Plants and animals live in communities that are more or less separated from one another by natural barriers. The makeup of each community is dependent upon the physical factors of that environment. The plants of the communities are the primary food producers. The plants of the sea are algae. The plants of the land are mostly seed plants.

The available food supplies vary with changes in the season. They may also vary from one year to another. In the plants, these foods are produced through the process of photosynthesis. In seed plants, this process is a result of the combined activities of the leaves, stems, and roots. The leaves are usually the main food-making centers, while the roots absorb water and minerals from the soil, and the stems hold the plants up on contact with sunlight as well as serve as pathways for fluids and nutriment.

The process of passing energy or food from one organism to another in a community is called a food chain. You start a chain with the sun and its supply of radiant energy. The plants absorb the energy and lock it into molecules of sugar, which is made from carbon dioxide in the air and from water and some minerals of the ground. Some minerals from the ground supply plants with the elements to make protein. The energy locked in plants is eaten by animals which need the energy for their survival. Some animals will eat other animals for their energy. If a plant or animal dies, organisms live off the remains and decompose it. The dead organism gives energy to parasites as well as minerals back to the soil. Plants again use the minerals and the cycle goes on.

Food groups of any community include the food makers, herbivores, carnivores, omnivores, parasites, and saprophytes. Complex food chains exist, in which the materials produced by the food makers are passed along from one organism to another. When food chains are disrupted, many organisms in the community may be adverely affected.

Successions take place in community life, and a species, which is abundant at one time, may be far less common at another time. Plant succession leads to the development of a large, old population and a balanced community. When there is a balance in nature, no food group is excessively large.

Many cycles or chains are found in nature, and it is very important for an ecologist to be familiar with these. Food is produced by living things and food is needed by living things. Living things store energy and use energy. Oxygen is given off and oxygen is used. Throughout life, plants and animals grow through constructive processes, only to be destroyed after death by other living things. Cycles that become apparent upon close observation are the oxygen cycle, carbon dioxide cycle, nitorgen cycle, and energy cycle.

The relationship organisms have is determined by the step they hold on a food chain or food web. They are either producers (all plants), consumers, or decomposers. Animals form a prey/predator relationship on a chain such as this. There may be many food chains in a community and a few food webs. It takes many food chains to make up a web.

The type of community life is determined by the physical environment of the area. Different communities include ponds, marshes, sea shore, forest, grassland, tundra, and so on. There may be a variety of communities in a large area called a Biome. The biomes include arctic, desert, temperate hardwood forest, tropical, rain forest, and marine. Animals and plants have adapted to their specific biome, but may fluctuate at times between some communities.

Classification

Since ancient times various scientists have attempted to devise a system for grouping and naming living and non-living things. The classification of these things helps in their study and use by scientists. Scientific classification is one of the best examples of the close cooperation of the biologists of the world. Their nationalities, customs, and native tongues may be different, but in the realm of science, they speak the same language because all classification is either in Latin or Greek. Through international cooperation, most organisms of the earth have been placed in orderly groups which are based on structural characteristics.

Common names can be very confusing when studying many kinds of animals. One person might be talking about a type of bear. There are many types of bears in many areas of the world. If the person names the scientific name of the bear, other people will know exactly what it looks like and where it found. This can be similar to a person's name (see chart below).

Classification of a letter:	
Country:	United States
State:	Washington
City:	Seattle
Street:	Madison
Number:	2435
Surname:	Smith
First name:	John

Classification of Grasshopper:		
	Kingdom:	Animalia
	Phylum:	Arthropoda (jointed-foot animals)
	Class:	Insecta (all insects)
	Order:	Orthoptera (straight winged)
	Family:	A cridiidae (locusts)
	Genus:	Schistocerca (cleft-tail)
	Species:	Americana (American)

Plants and animals vary greatly around the world. Through an orderly classification, they can be studied more easily and used more readily.

Scientific Method

The attitude with which you approach a problem is very important to the way the problem or experiment will turn out. The scientific attitude is one which is characterized by: 1) open-mindedness - a scientist must free his mind from prejudice and never reject knowledge because it happens not to agree with an idea of his own, 2) careful judgment - never jump to conclusions, 3) desire to learn - health curiosity, wanting to know the "why" of things, 4) belief in cause and effect - things happen for a reason, and 5) active concern for human welfare - produce better things for better living.

The way most people go about solving a problem can be outlined and follows steps we call the scientific method. This outline or method of solving problems is as follows:

1. Recognize a problem and define the problem.
2. Collect information related to the problem.
3. Form an idea or hypothesis as to how the problem may be solved.
4. Experiment to prove or disprove the hypothesis.
5. Observe the experiment.
6. Organize and record data from the experiment.
7. Draw conclusions from data.

Scientific Method

The solving of problems may contain all or a few of these steps. The main idea is to define a problem, study the problem, and solve the problem from information gained by observing and studying.

SCHEDULE:

This unit has as its basic theme - ECOSYSTEMS. The number of such possible systems for study will vary from classroom to classroom, but the list seems endless. Some of the more obvious include:

- Study of a school yard plot
- Study an aquarium environment
- Study a desert environment
- Study a swamp environment
- Study a cold environment
- Study a warm environment
- Study a forest environment

The science kit materials are available to you for a three-week period. Since several of the lessons continue beyond the request time, it will be necessary that certain activities be done during the three week period. The equipment you return, in the kit, will not hamper the continuing activities.

If you were to read the guide once or twice, in order to capture the overall ideas, you could then play it by ear with your children. However, feel free to use the unit as it is written. The lesson patterns are arranged so that they can be interrupted at several points. It is suggested that the initial field work and mapping exercises follow immediately the introductory discussion. The lessons do not have to follow the sequence shown in the guide.

The Instructional Resource Center has several very excellent films which can be used with this unit or work. Take a few minutes and preview those pertaining to Ecology.

EVALUATION:

Evaluating activity type programs by traditional paper and pencil tests is difficult to do. Unless you keep close observation records of exactly what the children are doing you will have no basis for traditional test design. We would suggest, therefore, that you become involved with the children as they experiment, observing their verbal comments to questions and discussion and their non-verbal behavior. Perhaps the following questions will help you to see what your children have learned by being involved in this unit of work.

EVALUATION:

Did your children -

1. Find different patterns for exploring problems?
2. Ask more self-questions as they progressed with the unit?
3. Determine some simple cycles for an environment?
4. Work better as team members?
5. Read stories and articles about the environment?
6. Identify several "new" organisms?
7. Apply information on environment system to others?
8. Evaluate the variables affecting different environments?

LESSON 1 THE SCHOOLYARD PLOT - INTRODUCTION

Concept: To become aware that plants and animals depend upon each other. To observe and experiment with different requirements that must be met by the environment. To observe changes in an environment and the resulting effects.

Materials:

KIT	NON-KIT
None	None

Procedure:

(Lead-off Question)

1. Ask, "How does the air around you affect you?" "How do you affect the air?"

2. As the students discuss these questions, lead them toward the interactions of many different things to the air and what we mean by environment.

(Follow-up Question)

3. Ask, "If we were to go outside and measure off a section of ground, what are some of the living things we might expect to find?"

4. Ask, "Will the living things on this plot always be the same?"

   "How long does the plot of ground remain the same?"

   "What changes do you expect to happen to the plot of ground?"

   "What effect does temperature, rainfall, and snowfall have on the plot?"

   "Are two plots of ground likely to be the same?"

   DON'T ATTEMPT TO COME TO CONCLUSIONS AT THIS TIME!

5. After discussing several of the preceding questions, ask, "Would you like to make a plot somewhere on the school grounds?"

   "Where would be a good place?" "Why?"

   "How big should our plot be?"

   "How do we mark it so that others don't destroy it?"

   "Should everyone have a piece of the plot?"

LESSON II THE SCHOOL YARD PLOT - MAPPING

Concept: To observe and record the environmental changes of a small area. To develop a census taking tool.

Materials:

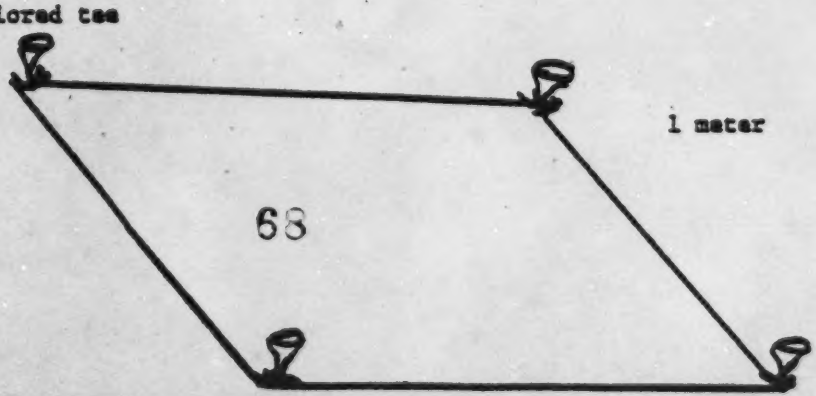
KIT	NON-KIT
Magnifying lens - 35	Guide book to plant identification
Golf tees - 70	

*Prior to beginning this activity you should look over the school grounds to find as many likely spots as possible. Select areas where there is little foot traffic. You might want to select different spots for various student teams in order to show the variety of small environments - e.g., one that is sunny and one that is in the shadows. Each team member will need a folder in which a record of the data is kept.

*There are two basic patterns which can be followed in setting up a plot for study - individual plots and a class plot which is divided into small sections. If you plan to use the class plot pattern, have your students measure off an area 10 meters on each side. Individual grids can then be made within the large area 1 meter on an edge. Either method for developing the plot is easy to set up. The lab lesson is developed to show what to do with the individual areas.

Procedure:

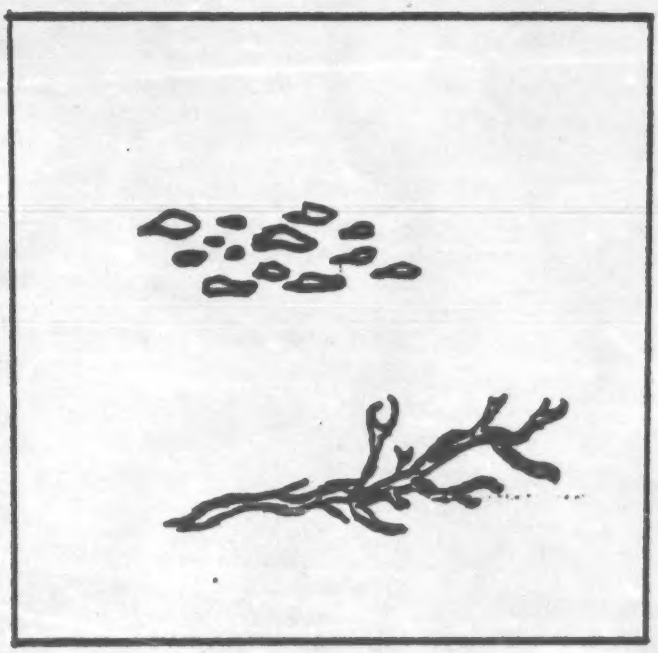
1. This lesson proceeds directly from Lesson 1.
2. Discuss, with the students, how they might mark their areas.
3. Once the markers have been determined (golf tees) and the class is cautioned about moving anything from their plot or walking all over it - move outside.
4. Pairs of students choose areas where they think they can find a thriving community. They then measure areas 1 meter square (use meter tapes), placing golf tees, surveyor's tape, or sticks level with the ground.



Plantain Plant

5. The students must not touch or disturb anything within their plot; they are only to observe and record their findings in a data notebook.

6. Some students may draw a scale drawing of their plot, showing symbols for the plants and animals they have observed. One possible drawing might look like the following:



Dandelion Plant

7. Ask, "How many different kinds of plants and animals did you find?

"How many of each kind?"

"Where were these plants within your plot?"

Possible answers could include - dandelions, grass, fireweed, spruce trees, etc.

8. The identification phase of this lesson can be as involved or as simple as you choose. The availability of identifiable material or reference books will determine the extent you would carry this exercise. It is not necessary to know scientific names! Some students might like to identify organisms by drawing pictures.

Grass Plant

LESSON III THE SCHOOL YARD PLOT - RECORDING OBSERVATIONS

Concept: To observe and record environmental changes in a small area.
To develop a census taking tool.

Materials:

KIT	NON-KIT
Magnifying lens - 35 Plastic rulers - 17 Thermometers - 4	None

*This lesson continues on where the last lesson left off. There is now one prescribed way each student group should proceed. However, a number of possible procedure questions should be decided on before the students continue with their plot. (See procedure, step 1.) Students need to observe their plot at least once per week for three weeks or longer.

Procedure:

(Lead-of Questions)

1. Ask, "Do you each want to be responsible for measuring and observing, or do you want to divide it up?"

   "Will measurements and records be kept for each plant on the plot or will a stated number of plants be chosen?"

   "Do you need to measure the height of growing plants?"
   "How can this be done?"

   What could happen if you rush to your plot?"

   Perhaps measurements are necessary.

2. One possible plant record data table the children might devise is as follows:

3. An animal record might look like this:

ANIMAL RECORD

DATE AND TIME	ANIMAL(S)	OBSERVATION
Wednesday 1:00 p.m.	1 Bumblebee	Bee visited three dandelion flowers
	16 Red Ants	Walked in a line carrying crumbs
	1 Grasshopper	Sat on a stem of grass

4. A weather record might look like this:

WEATHER RECORD

DATE AND TIME	GENERAL WEATHER CONDITIONS	TEMPERATURE	CONDITIONS OF SOIL SURFACE	SNOW DEPTH

5. After the students have had a few observation sessions they should begin to answer questions such as the following:

"Is the plot sunny or shady?"
"What kind of plants are on the plot?"
"Does the plot have rocks?"
"Is the plot where people walk?"
"Are any of the plants on the plot about to bloom?"
"How many kinds of living things did you find?"
"How many plants?" "How many animals?"
"Were the living things on one plot exactly the same on other plots?"
"Does the plot with fewer animals have fewer plants?"
"Does the plot with fewer animals have less sun?"
"How many new plants appeared on your plot?"
"Does one plot get more or less water than most of the other plots?"
"Who observed the most new plants?"
"Is the soil on one plot the same as on others?"
"Does rain affect the plants?"
"How did bright sunlight affect the plants?"
"How did temperature affect the plants?"
"How did rain affect the animals?"
"Did you see more animals on sunny days or cloudy days?"
"How does frost affect the plants and animals?"
"How does snow affect the plants and animals?"

6. Notice that the questions and experimentation resulting can be endless. Perhaps you can develop such a list with your children. Remember, the plot is dynamic - always changing. New growth, wilting, broken branches, new born animals, dead animals, damaged areas, are all part and parcel of the dynamic change.

CAUTION - Look ahead - you will need to call the science center (278-9531) to schedule stereoscopes for the next lesson.

LESSON IV STUDY A PLOT ONE FOOT DOWN

Concept: To compare differences between soil near the surface and soil deeper in the ground.

To observe living organisms which live beneath the surface of the soil.

Materials:

KIT	NON-KIT
*Stereoscope - 3	Bright light
Magnifying lens - 35	Pill bottle
Petri dishes - 10	Cheese cloth
Plastic sheets - 10	Alcohol
Aluminum sheet - 1	Funnel

*Prior to the day you introduce this lesson, find a likely soil sample which you can dig and bring to class. You will need a fresh sample about 1' x 1' x 8". The depth should include plant roots. If possible, the sample should come from an area which has not been cultivated in some years and should be covered with vegetation and contain some animal life such as worms. Avoid areas near trees or large bushes. If the weather has been dry, it would be wise to water the soil the night before cutting the pieces.

Procedure:

1. Bring the soil sample, mentioned above, to class. Have a student measure the approximate depth of the ground.

2. Cut the soil sample into 8 horizontal pieces so that each part provides a complete cross section from top to bottom.

3. Give each group of four students one section of the soil and a piece of plastic to place the soil on.

(Lead-off Question)

4. Ask, "Can you find any animals in your sample?" "What about animal eggs?"

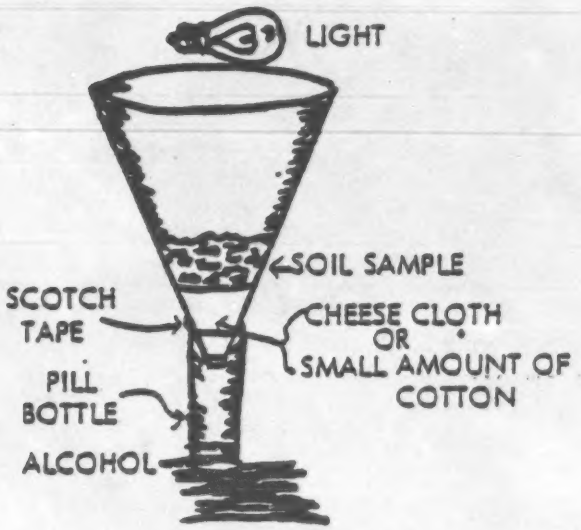
5. Caution the students to move carefully and to use their magnifying glasses. Students can use the stereoscopes to look at their samples with the scopes as well as with the magnifying lenses.

6. After an appropriate time the plant and animal profiles can be put on the board.

* Be sure to call the science center for stereoscopes. They will be sent to you for 1 week only.

LESSON IV STUDY A PLOT ONE FOOT DOWN

7. One possible extension you might like to try is shown in the following diagram. The light and heat, from the light, will force the animals down into the pill bottle. Leave set-up going overnight.



LESSON V - VII ENVIRONMENTAL FACTORS (Optional)

*A number of individual team explorations can be carried on during the unit of work. Some of the possible activities are described briefly. Most of the equipment needed for these activities has not been included in the kit; however, the items necessary can easily be obtained by the students or requested on an individual basis from the science center - 278-9531.

LESSON VI LIGHT AS AN ENVIRONMENTAL FACTOR

Students can explore the shoots grown from potato eyes in three different light conditions - dark, medium and bright light intensities. The potatoe shoots will respond differently to different light intensities - more light, less initial growth.

The student teams will need the following items:

1 potato - to be cut in three approximately equal parts.
1 dish - to put potato in (cottage cheese, etc.)
Pebbles - enough to cover bottom of dish

Questions such as the following can be answered by this experiment.

"Do potatoes or shoots respond to light?" "how?"
"Did all shoots under the same light grow the same amount?"
"Should potatoes be planted above or below the ground?"
"Should potatoes be grown in the light or dark?"
"How small a section of potato will grow?"
"Were all your conditions, other than light, the same?"
"What part of the potato grows?"
"What happens to the rest of the potato section as the shoots grow?"

LESSON VI RESPONSES OF BEETLES TO LIGHT AND DARK

This activity allows the children to design an experiment. The problem, "Does the Tenebrio beetle (mealworm) respond to light?" (Tenebrio beetles can be obtained as mealworms and allowed to mature to the adult stage, from the Science Kit Center) is one which allows for testing one of the environmental factors.

The experiment should be non-directed in that the children are told what to do. Rather than tell, ask a few questions. Better yet, let the students come up with their own design.

"What equipment can we use?"
"What kind of light do we try?" "How many lights?"
"How can we make a dark place for the beetles?"
"Should all the environmental conditions be the same except light?"

Questions you may want to ask as the children experiment are:

"How many times did beetles stay in lighted areas?"
"How many times did beetles stay in dark areas?"
"Why did your group get different results?"
"Will a brighter light make a beetle move faster than a light that is not so bright?"
"Can a beetle see?"
"Do beetles come out at night?"

LESSON VII RESPONSES OF BEETLES OF DIFFERENT TEMPERATURES

The children will have another opportunity to design and carry out an experiment with different temperatures rather than light. Again the design and experimentation should be student directed.

Questions you might ask include:

"Which temperature is the one at which most beetles turned away?"
"Do beetles respond to hot air?"
"How does a beetle react to an ice cube?"

OTHER LESSONS A number of lessons dealing with environmental factors are possible. Perhaps some of the following will interest your children.

1. How does water affect seed germination? Do all seeds need the same amount of water to germinate?
2. What affect does water have on snail activity?
3. How does an earthworm respond to a flooded habitat?
4. Does the amount of fertilizer used affect the growth of beans?
5. Do growing plants affect other organisms?

OTHER UNITS See "Mealworms" grade 6 and "Environments of Flowering Plants" grade 6. Also SCIS 4, 5, and 6.